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| 10/811,442 | 03/26/2004 | Liang Liu | | 1467 |

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WEI TE CHUNG
FOXCONN INTERNATIONAL, INC.
1650 MEMOREX DRIVE
SANTA CLARA, CA 95050

| EXAMINER | |
|---|---|
| CANNING, ANTHONY J | |
| ART UNIT | PAPER NUMBER |
| 2879 | |

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Please find below and/or attached an Office communication concerning this application or proceeding.

H·A

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/811,442 | LIU ET AL. | |
| | Examiner | Art Unit | |
| | Anthony J. Canning | 2879 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *28 February 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1,3-9 and 11-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-9 and 11-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Acknowledgement of Amendment*

1. The amendment to the instant application was entered on 28 February 2006.

### *Claim Rejections - 35 USC § 102*

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 16-19 is rejected under 35 U.S.C. 102(e) as being anticipated by Chang et al. (U.S. 2003/0044537 A1).

4. Regarding claim 16, Chang et al. disclose a method of making a carbon nanotube-based field emission device, comprising steps of: providing a catalyst layer (paragraph 0014); growing a carbon nanotube array on said catalyst layer wherein carbon nanotubes in said array extend from said catalyst layer with roots and define different heights with tips (see Fig. 26, item 25 paragraph 0014); the protection layer is what the examiner interprets as the catalyst layer); applying a cathode electrode to said tips of said carbon nanotubes (see Fig. 2E, item 22; paragraph 0014); separating said carbon nanotubes from said catalyst layer and exposing said

roots (paragraph 0014; removal of the protection layer); and providing a gate electrode beside said roots (see Fig. 2E, item 24; paragraph 0014; the second conducting layer).

5. Regarding claim 17, Chang et al. disclose the method as described in claim 16. Chang et al. further disclose that the gate electrode is supported by a barrier, which is seated upon the cathode electrode (see Fig. 2G, item 23; paragraph 0025).

6. Regarding claim 18, Chang et al. disclose the method as described in claim 17. Chang et al. further disclose that the height of said barrier is similar to a common height of said carbon nanotubes measured from the cathode electrode (see Fig. 2G, items 23 and 26 are a similar height).

7. Regarding claim 19, Chang et al. disclose the method as described in claim 17. Chang et al. further disclose that the cathode electrode is originally supportably seated upon said barrier for applying said cathode electrode to the tips after growth of said carbon nanotubes (paragraph 0014).

***Claim Rejections - 35 USC § 103***

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out

the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

9. Claims 1, 4, 7-9, 11, 14 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Han et al. (U.S. 6,515,415 B1) in view of Dai et al. (U.S. 6,232,706 B1).

10. As to claim 1, Han et al. disclose a carbon nanotube-based field emission device comprising: a cathode electrode (see Fig. 3, item 120; column 3, lines 54-57); and a carbon nanotube array of nanotube members, the carbon nanotube array of the nanotube members extending from a root end to a growth end, the carbon nanotube array being aligned perpendicularly from the cathode electrode (see Fig. 3, items 121; column 3, lines 54-57) and having a growth end embedded in the cathode electrode and an opposite root end (the end of the carbon nanotubes attached to the cathode is interpreted by the examiner as the growth end, and the end of the carbon nanotube that is not attached to the cathode as the root end); wherein the growth end of the carbon nanotube array is in electrical contact with the cathode electrode (see Fig. 3, items 120 and 121; because the cathode and the carbon nanotubes are physically touching one another, and the highly conductive nature of nanotubes, they are in electrical contact with one another), and the root end defines a substantially planar surface (see Fig. 3, the root end of the carbon nanotubes are planar in the horizontal direction). Han et al. fail to disclose that the root end has a flatness of less than one micron across the nanotube array.

Dai et al. disclose a field emission device with a variation flatness of the planar surface less than 1 micron (column 3, lines 19-32; column 4, lines 11-15; here it says that the nanotubes can have a flat surface, which the examiner interprets to mean completely flat and therefore a

variation less than 1 micron). Having uniformly flat nanotubes allows for desirable emission of electrons.

Therefore, it would have been obvious to one having ordinary skill in the art, at the time the invention was made, to modify the field emission device of Han et al. to include nanotubes with a variation in flatness of the planar surface is less than 1 micron, as taught by Dai et al., for the desirable emission of electrons.

11. As to claim 9, Han et al. disclose a carbon nanotube-based field emission device comprising: a carbon nanotube array which grows from a root end and extends to a growth end (see Fig. 3, items 121; column 3, lines 54-57; the end of the carbon nanotubes attached to the cathode is interpreted by the examiner as the growth end, and the end of the carbon nanotube that is not attached to the cathode as the root end); and a cathode electrode formed on and covering the growth end of the carbon nanotube array (see Fig. 3, item 120; column 3, lines 54-57); wherein the root end defines a substantially planar surface which is exposed outwardly and acts as an emitter (column 4, lines 53-57), and the growth end is substantially embedded into the cathode electrode (see Fig. 3, items 120 and 121; because the cathode and the carbon nanotubes are physically touching one another, and the highly conductive nature of nanotubes, they are in electrical contact with one another).

Han et al. fail to disclose that the root end has a flatness of less than one micron across the nanotube array.

Dai et al. disclose a field emission device with a variation flatness of the planar surface less than 1 micron (column 3, lines 19-32; column 4, lines 11-15; here it says that the nanotubes can have a flat surface, which the examiner interprets to mean completely flat and therefore a

variation less than 1 micron). Having uniformly flat nanotubes allows for desirable emission of electrons.

Therefore, it would have been obvious to one having ordinary skill in the art, at the time the invention was made, to modify the field emission device of Han et al. to include nanotubes with a variation in flatness of the planar surface is less than 1 micron, as taught by Dai et al., for the desirable emission of electrons.

12. As to claims 4 and 11, Han et al. and Dai et al. disclose the field emission device as described in claims 1 and 9. Han et al. further disclose that the carbon nanotube array comprises a plurality of carbon nanotubes, each of which has an open tip (carbon nanotubes by definition are hollow carbon structures).

13. As to claim 7, Han et al. and Dai et al. disclose the field emission device as described in claim 1. Han et al. further disclose an insulative barrier having a height just exceeding the planar surface of the root end (see Fig. 3, item 130; column 1, lines 22-23) is formed adjacent the carbon nanotube array and at least a gate electrode is formed on the barrier such that the gate electrode is separated from the cathode electrode (see Fig. 3, item 140; column 3, lines 58-59).

14. As to claim 8, Han et al. and Dai et al. disclose the field emission device as described in claim 7. Han et al. further disclose that the root end of the carbon nanotube array almost reaches the interface between the barrier and the gate electrode (see Fig. 3, items 121 and 130; since almost is a not any definite amount, the examiner interprets the height of the carbon nanotubes in the figure to be about the same height as the insulating barrier ribs).

15. As to claim 14, Han et al. and Dai et al. disclose the field emission device as described in claim 9. Han et al. further disclose at least a gate electrode is formed adjacent the carbon

nanotube array at a height above the planar surface of the root end (see Fig. 3, item 140; column 3, lines 58-59).

16. As to claim 15, Han et al. and Dai et al. disclose the field emission device as described in claim 14. Han et al. further disclose the gate electrode is supported by an insulative barrier formed adjacent the carbon nanotube array (see Fig. 3, item 130; column 1, lines 22-23), such that the gate electrode is separated from the cathode electrode (see Fig. 3, items 121 and 140).

17. Claims 3, 5, 6, 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Han et al. (U.S. 6,515,415 B1) in view of Dai et al. (U.S. 6,232,706 B1) and in further view of Nakamoto (U.S. 6,097,138).

18. As to claim 3, Han et al. and Dai et al. disclose the field emission device as described in claim 1. Han et al. and Dai et al. fail to specifically disclose that the cathode electrode is made of copper.

Nakamoto discloses a field emission display, which has a cathode electrode, made of copper (column 4, lines 60-62). Copper makes ideal cathodes due to their conductive properties.

Therefore, it would have been obvious to one having ordinary skill in the art, at the time the invention was made, to modify the field emission device of Han et al. to include a copper cathode, as taught by Nakamoto, to take advantage of copper's ideal conductive properties.

19. As to claims 5, 6, 12, and 13, Han et al. and Dai et al. disclose the field emission device as described in claims 1 and 9. Han et al. and Dai et al. fail to specifically disclose that the height of the carbon nanotube array is in the range from 5 microns to 10 mm, more specifically between 10 to 500 microns.

Nakamoto discloses a field emission display with carbon nanotube emitters wherein the height of the carbon nanotube array is in the range from 5 microns to 10 mm, and more specifically between 10-500 microns (Abstract; given the aspect ratio is the height/diameter, one can calculate the height of the nanotubes, which falls within the given range). It is advantageous to have the nanotubes a certain height, with respect to their diameter, as to adjust the voltage applied to the nanotubes to have them emit electrons.

Therefore, it would have been obvious to one having ordinary skill in the art, at the time the invention was made, to modify the field emission device of Han et al. to include that the height of the carbon nanotube array is in the range from 5 microns to 10 mm, more specifically between 10 and 500 microns, as taught by Nakamoto, to be able to use the height of the nanotubes as a way to emit electrons at a desired voltage.

20. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chang et al. (U.S. 2003/0044537 A1).

As to claim 20, Chang et al. disclose the method as described in claim 16. Chang et al. further disclose that the catalyst layer is provided on a planar surface of a working plate (paragraph 0014, the portion of the display that is grown on the protection layer). Chang et al. fail to disclose that the working plate has a flatness of less than 1 micron. However, Iit would have been obvious to one having ordinary skill in the art at the time the invention was made to that the working plate has a flatness of less than 1 micron, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

***Response to Arguments***

21. The examiner acknowledges amendments to claims 1, 7-9 and 18, the cancellation of claims 2 and 10, and newly added claim 20.

22. The examiner removes the objection to claims 1, 7-9 and 18.

23. The examiner does not find the applicant's argument about the degree of flatness unconvincing. First, Dai et al. disclose that the nanotube bundles are flat topped (column 3, lines 24-25). This in combination with Han et al. render claims 1 and 9 obvious. Furthermore, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

24. The examiner holds the position that the protection layer is a catalyst layer in that it is used in the formation of the carbon nanotubes on the cathode.

***Final Rejection***

25. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37

CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

***Contact Information***

26. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anthony J. Canning whose telephone number is (571)-272-2486. The examiner can normally be reached on M-F 8:00-4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nimesh D. Patel can be reached on (571)-272-2457. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Anthony Canning
10 May 2006

ASHOK PATEL
PRIMARY EXAMINER